

Informational Leaflet

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SOME FEEDING HABITS OF THE ANADROMOUS
DOLLY VARDEN SALVELINUS MALMA (WALBAUM)
IN SOUTHEASTERN ALASKA

By:

Robert H. Armstrong
Division of Sport Fish

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STATE OF ALASKA
WILLIAM A. EGAN - GOVERNOR
DEPARTMENT OF
FISH AND GAME
WALTER KIRKNESS - COMMISSIONER
SUBPORT BUILDING, JUNEAU



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SALVELINUS MALMA (WALBAUM) IN SOUTHEASTERN ALASKA¹

INTRODUCTION

The food and feeding habits of the anadromous Dolly Varden *Salvelinus malma* (Walbaum) were investigated by the Sport Fish Division as part of a life history study conducted at Eva Lake, on the northeast corner of Baranof Island, Southeastern Alaska. The Dolly Varden of the Eva Lake watershed migrate to sea in the spring. At sea they travel in all possible directions and then enter many other stream systems. After spending a few days to several months in these streams they again migrate to salt water. A portion returns to Eva Lake in the fall, where they remain throughout the winter. An average of 116 days is spent away from the Eva Lake system by the returning Dolly Varden, the rest of the time, or 249 days, is spent in the system. For a more detailed coverage of these migration patterns see Armstrong (1965).

The life history of Dolly Varden was arbitrarily divided into the following six periods for this study:

1. Outmigration period
2. Salt water period
3. Immigration at Saook Creek (nonlake system ten miles west of Eva Lake)
4. Immigration at Eva Creek
5. Eva Lake - summer residence
6. Eva Lake - winter residence

The objectives were: (1) to investigate throughout the year the food and feeding habits of Dolly Varden during these six life history periods, (2) to obtain an indication of the digestive rate of Dolly Varden and (3) to assess the seriousness of the Dolly Varden as a predator on salmon young and eggs.

METHODS

Dolly Varden were collected at the Eva Creek weir located below the lake outlet and at the Saook Creek weir located on a nonlake system about 10 miles west of Eva Lake (Figure 1). The Eva Creek weir is situated at the widest portion of the creek (160 feet) approximately 250 yards above tidewater. The Saook Creek weir is situated in a similar manner where the creek is 100 feet wide, approximately 1/2 mile above tidal influence. A detailed description of these study

¹ This investigation was conducted with Federal-Aid in Fish Restoration Funds under Project F-5-R-4 (1962-1963), F-5-R-5 (1963-1964) and F-5-R-6 (1964-1965).

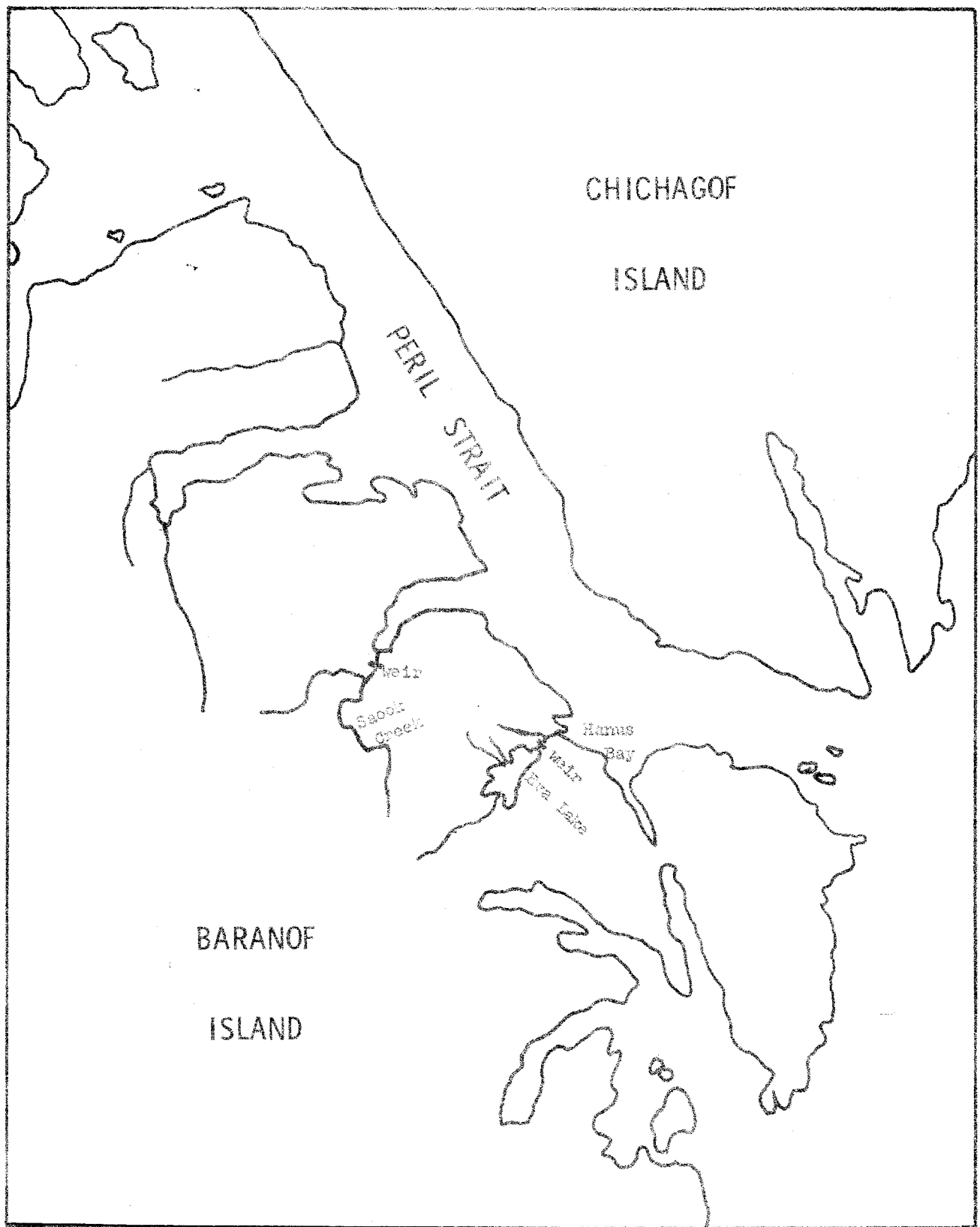


Figure 1. Sketch map showing the location of the study area (approximate scale: 1" = 4 miles).

areas and weirs is given by Armstrong (1965). The char was randomly collected from the Eva Creek weir traps during their outmigration period from May 5 to June 17 in 1962, March 27 to July 10 in 1963, and May 10 to June 19 in 1964. During the immigration period Dolly Varden were randomly collected from the Eva Creek weir traps from July 16 to August 16 in 1962, from June 23 to December 17 in 1963, and from the Saook Creek weir trap from June 13 to August 21, 1963.

Dolly Varden were captured in Eva Lake from August 6 to 21, 1962 with sports-fishing tackle (26.3 percent) and a fyke net (73.7 percent), consisting of two 4 by 6 foot rectangular frames followed by four circular hoops, 4 feet in diameter, covered with 1/2 inch nylon mesh (bar measure).

Between January 6 and March 30, 1964 the char were captured in Eva Lake with a gill net, 125 feet by 6 feet deep with 25-foot sections of 1/2, 3/4, 1, 1-1/2, and 2 inch mesh (bar measure).

The char were captured in salt water (Hanus Bay) between May 31 to August 5, 1962 with two gill nets (49 percent) identical to those used in the lake, and on sports-fishing tackle (51 percent).

The char captured in the Eva and Saook weir traps and in Eva Lake were examined as soon as possible after capture. Each fish was measured (fork length) to the nearest millimeter, weighed to the nearest tenth of a pound and the stomach contents from the esophagus to the pylorus were recorded. Individual food items were not counted, nor were measurements of volume or weight taken. Results of stomach analysis are expressed as "frequency of occurrence". Each food item is given equal weight, regardless of the amount consumed. Percentage occurrence of each food item was obtained by dividing the number of fish containing a specific food by the total number of fish with food in their stomachs.

Stomachs were taken from the char captured in salt water as soon as possible after capture and preserved in a 10 percent formalin solution. The stomach contents were identified approximately six months after capture. The "frequency of occurrence" of each food item was determined by the same methods used on the creek and lake samples. Additional information was obtained by counting individual food items and measuring their volume to the nearest millimeter.

A single experiment to determine the digestive rate of Dolly Varden was conducted by force feeding two freshly killed sockeye salmon fry to each of 18 Dolly Varden and noting the state of decomposition at specific intervals of time. The results of this experiment are presented to give an indication of the digestive rate of Dolly Varden and no attempt is made to correlate the findings with their feeding habits.

An attempt to assess the seriousness of the Dolly Varden as predator on salmon young and eggs was made by a thorough search of the literature concerned with this subject. The conclusions were drawn from the results of previous investigators and of the present study.

RESULTS

Outmigration Period - Eva Creek Weir

A sample of 1,372 Dolly Varden outmigrants were collected from the weir at Eva Creek. The results of the stomach content analysis of these fish are presented in Table 1. Only 285 (21 percent) of the stomachs of this sample contained food. Fish with food in the stomach ranged in fork length from 103 to 502 mm with a mean of 226 and in weight from 0.02 to 2.36 pounds with a mean of 0.24.

Insects were the most frequently occurring food item, being found in 217 (76.1 percent) of the stomachs with food. Gastropods were second in abundance, occurring in 39 (13.7 percent) of the feeding char. Other food materials and their percentage occurrence were: fish remains (1.8 percent); salmon young (1.1 percent) and salmon scales (0.7 percent). Dolly Varden young, salmon eggs, and cottid eggs each had 0.4 percent occurrence.

The young of chum, coho, pink, and sockeye salmon were available to the Dolly Varden throughout the study periods. Records obtained from outmigrant fry traps indicated that the outmigrations of salmon young coincided with the Dolly Varden outmigration. Dolly Varden were repeatedly observed swimming around and through schools of sockeye salmon smolts in front of the weir, but seldom during these observations were Dolly Varden observed actively chasing or feeding on the young sockeye smolts. Toward the end of the migration period in late June and early July an occasional Dolly Varden was seen chasing the sockeye smolts. Possibly the lack of interest observed earlier was due to low water temperatures (38 to 44° F.). Whereas in late June and early July the water temperature had risen (50 to 57° F.).

The relative amount of feeding on certain foods in each of the three years remained about the same (Table 1). Insects and gastropods were the predominant food in each of the study years.

Salt Water Period

A sample of 145 Dolly Varden was collected in the Hanus Bay region. The results of the stomach content of these fish are presented in Table 2. Of the 145 char stomachs examined, 102 (70 percent) contained food. Fish with food in the stomach ranged in fork length from 121 to 490 mm with a mean of 274 and weighed from 0.03 to 3.01 pounds with a mean of 0.66.

The principal foods by percent of volume were salmon young (28.1 percent), capelin (21.7 percent), Pacific herring (17.1 percent) and mysids (9.0 percent). The principal foods by frequency of occurrence were salmon young (21.6 percent), mysids (17.6 percent), amphipods (12.7 percent), and capelin (9.8 percent).

Young salmon were available to the Dolly Varden in Hanus Bay throughout the study period. During this period young of the pink, chum, and coho were repeatedly observed. Pink and chum salmon young were collected by beach seine in Hanus Bay at various intervals throughout the study period. Although these two species appeared to grow rapidly, (Table 3) they did not attain lengths during the study period that would render them invulnerable to predation

Table 1. Stomach contents of Dolly Varden captured at the Eva Creek weir during their outmigration in 1962, 1963, and 1964.

Stomach Content	1962 5/15-6/17		1963 3/27-7/10		1964 5/10-6/19		TOTAL	
	Incidence of Feeding	Percent Occur- rence in Feeding Fish	Incidence of Feeding	Percent Occur- rence in Feeding Fish	Incidence of Feeding	Percent Occur- rence in Feeding Fish	Incidence of Feeding	Percent Occur- rence in Feeding Fish
Fish:								
Dolly Varden young	-	-	1	0.5	-	-	1	0.4
Salmon young	1	2.7	2	1.1	-	-	3	1.1
Fish material:								
Cottid eggs	-	-	-	-	1	1.6	1	0.4
Salmon eggs	-	-	1	0.5	-	-	1	0.4
Salmon scales	-	-	2	1.1	-	-	2	0.7
Unidentified fish remains	-	-	4	2.2	1	1.6	5	1.8
Miscellaneous:								
Gastropods	5	13.5	27	14.7	7	10.9	39	13.7
Insects	21	56.8	143	77.7	53	82.8	217	76.1
Rocks & wood	1	2.7	11	5.8	9	14.1	21	7.4
Unidentified material	9	24.3	10	5.4	2	3.1	21	7.4
Number empty	482		441		164		1,087	
Number feeding	37		184		64		285	
Total examined	519		625		228		1,372	

Table 2. Stomach contents of Dolly Varden captured in salt water, 1962.

Stomach content	Incidence of Feeding	Percent Occurrence in Feeding Fish	Percent of Total Volume
Fish:			
Capelin	10	9.8	21.7
Herring	6	5.9	17.1
Liparids	3	2.9	2.3
Salmon young	22	21.6	28.1
Sand lance	2	2.0	1.9
Fish material: Unidentified fish remains	26	25.5	11.7
Crustacea:			
Amphipods	13	12.7	2.9
Decapods	2	2.0	0.1
Euphausiids	9	8.8	2.0
Isopods	4	3.9	1.1
Mysids	18	17.6	9.0
Tanaidacids	8	7.8	0.4
Unidentified crustacea	3	2.9	0.2
Miscellaneous:			
Gastropods	1	1.0	0.0
Polychaete worms	3	2.9	0.8
Unidentified material	6	5.9	0.5
Number empty = 43 Number feeding = 102 Total examined = 145			

Table 3. The average fork length of pink and chum salmon young sampled in Hanus Bay - 1962.

Date	Pink		Chum	
	Number	Mean Length (mm)	Mean	Mean Length (mm)
6/21	27	51.10	62	49.10
6/28	6	61.50	71	60.90
7/ 5	41	76.72	85	72.09
7/12	12	87.25	48	83.27

by the Dolly Varden. An estimated total of 56 pink and chum salmon remains was identified in twenty-two (21.6 percent) char. No coho salmon young were identified in any of the stomachs.

The capelin occurred in about one out of every ten specimens studied. Although only 20 capelin were found in 10 char, the total volume (21.7 percent) was second highest. This is due to the relatively large size (87 to 153 mm) of the capelin, which was the largest fish found to be consumed by the Dolly Varden.

The Pacific herring occurred in greater numbers than any other fish eaten by the Dolly Varden (182). However, since the Pacific herring was eaten as larvae, the total volume was not as great as the larger salmon young and capelin. Their remains were identified in six (5.9 percent) of the char.

The only other fish found in the Dolly Varden stomachs were the Pacific sand lance and an unidentifiable member of the family Liparidae, or snailfish. Two of the chars that were examined contained fourteen Pacific sand lances which resulted in a total volume of 1.9 percent and a frequency of occurrence of 2.0 percent. Seven snailfish were found in three Dolly Varden. Their total volume was 2.3 percent and they occurred in 2.9 percent of the feeding char. The lobe-fin snailfish was frequently obtained by beach seine in Hanus Bay and this was probably the species observed in the stomachs of the char.

The principal crustacean (1,269) eaten by the Dolly Varden was a member of the family Mysidacea. They occurred in 18 of the char stomachs examined. Other members of the crustacea that occurred included amphipods (157), euphausiids (147), isopods (66), tanaidacids (53), and decapods (16). The only other invertebrate food material found was six polychaete worms in three Dolly Varden and one gastropod in a single fish.

Inmigration at Saook Creek

Stomachs of 388 in migrant Dolly Varden were examined at Saook Creek. The results of the stomach content analysis of these fish are shown in Table 4. A total of 263 stomachs (68 percent) contained food. These fish ranged in length from 135 to 503 mm with a mean of 248.

Salmon eggs were the most frequently occurring food item and were found in 61.7 percent of the stomachs with food. Insects were second in abundance, occurring in 38.4 percent of the feeding char. Other food material and their percentage occurrence were fish remains (1.5 percent), amphipods (0.4 percent) and leeches (0.4 percent).

Inmigration at Eva Creek

A sample of 1,542 Dolly Varden immigrants was collected from the weir at Eva Creek. The results of the stomach content analysis of these fish are presented in Table 5. Only 349 (23 percent) of the stomachs of this sample contained food. Fish with food in the stomach ranged in length from 131 to 500 mm with a mean of 260 mm and weighed from 0.04 to 2.77 pounds with a mean of 0.47 pounds.

Salmon eggs were the most frequently occurring food item and were present in 61.3 percent of the feeding char. Other food material and their percentage

Table 4. Stomach contents of Dolly Varden captured at the Saook Creek weir during their immigration, 1963.

Stomach Content	Incidence of Feeding	Percent Occurrence in Feeding Fish
Fish material:		
Salmon eggs	162	61.6
Unidentifiable fish remains	4	1.5
Crustacea:		
Amphipods	1	0.4
Miscellaneous:		
Insects	101	38.4
Leeches	1	0.4
Rocks & wood	20	7.6
Unidentified material	17	6.5
Number empty = 125 Number feeding = 263 Total examined = 388		

Table 5. Stomach contents of Dolly Varden captured at the Eva Creek weir during their immigration in 1962 and 1963.

Stomach Content	1962 7/16-8/16		1963 6/23-12/17		Total	
	Incidence of Feeding	Percent Occur- rence in Feeding Fish	Incidence of Feeding	Percent Occur- rence in Feeding Fish	Incidence of Feeding	Percent Occur- rence in Feeding Fish
Fish:						
Sand lance	2	3.4	-	-	2	0.6
Stickleback	1	1.7	-	-	1	0.3
Fish material:						
Dolly Varden eggs	-	-	4	1.4	4	1.1
Salmon eggs	10	17.2	204	70.1	214	61.3
Unidentified fish remains	13	22.4	10	3.4	23	6.6
Crustacea:						
Amphipods	2	3.4	4	1.4	6	1.7
Euphausiids	2	3.4	-	-	2	0.6
Mysids	2	3.4	1	0.3	3	0.9
Miscellaneous:						
Gastropods	5	8.6	3	1.0	8	2.3
Insects	7	12.1	51	17.5	58	16.6
Polychaete worms	3	5.2	-	-	3	0.9
Rocks & wood	7	12.1	9	3.1	16	4.6
Unidentified material	11	19.0	37	12.7	48	13.8
Number empty	724		469		1,193	
Number feeding	58		291		349	
Total examined	782		760		1,542	

occurrence were fish remains (6.6 percent); gastropods (2.3 percent); amphipods (1.7 percent); Dolly Varden eggs (1.1 percent); polychaete worms (0.9 percent); mysids (0.9 percent); euphausiids (0.6 percent); sand lance (0.6 percent); and stickleback (0.3 percent). Many of these items were undoubtedly eaten in salt water by the Dolly Varden immigrants.

The Dolly Varden appeared to feed to a greater extent on salmon eggs in 1963 than in 1962 (Table 5). This is probably because more salmon entered Eva Creek in 1963 and the sampling period in 1963 covered the salmon spawning period more accurately than in 1962.

Eva Lake - Summer Residence

A sample of 176 Dolly Varden from Eva Lake between August 6-21 showed 59 (33.5 percent) of these fish contained food in their stomachs. They ranged in length from 112 to 375 mm with a mean of 198. Weight ranged from 0.03 to 1.35 pounds with a mean of 0.22. The results of the stomach content of these fish are presented in Table 6. Gastropods were the most frequently occurring fish item and were found in 64.4 percent of the feeding char. Insects, predominately Trichoptera, occurred in 22.0 percent, salmon eggs in 18.6 percent, and fish remains in 3.4 percent of the Dolly Varden.

The three-spined stockleback and sockeye salmon fry were repeatedly observed and taken by beach seine in large numbers throughout Eva Lake during the sample period; however, neither of these species were found in the Dolly Varden stomachs examined.

Eva Lake - Winter Residence

A sample of 265 Dolly Varden collected in Eva Lake between January 6 and March 30 showed that only 23 (8.7 percent) of these fish contained food. They ranged in length from 190 to 416 mm with a mean of 244. Weight ranged from 0.12 to 1.75 pounds with a mean of 0.33. The results of the stomach content of these fish are presented in Table 6. Gastropods were the most frequently occurring food item and were found in 70.0 percent of the feeding char. Insects occurred in 13.0 percent, freshwater clams in 8.7 percent and isopods in 4.3 percent of the Dolly Varden.

Number Feeding by Area:

The relative amount of feeding by the Dolly Varden during certain life history periods is shown in Table 7. The greatest amount of feeding occurred in salt water. A high percentage of feeding also occurred in Saook Creek, a nonlake system. The higher percentage of feeding in Saook Creek than in Eva Creek can be attributed to a greater availability of salmon eggs per fish in Saook Creek during the sampling period.

The least amount of feeding occurred during the winter in Eva Lake. Low water temperatures, ice cover, and availability of food probably contribute to the lack of Dolly Varden feeding during this period. Unpublished age and growth data on the Eva Lake char show only slight length increments between the in and outmigrations and an actual weight loss during the winter months.

Table 6. Stomach contents of Dolly Varden captured in Eva Lake during the summer of 1962 and the winter of 1964.

Stomach Content	1962 8/6—8/21		1964 1/6—3/30		Total	
	Incidence of Feeding	Percent Occur- rence in Feeding Fish	Incidence of Feeding	Percent Occur- rence in Feeding Fish	Incidence of Feeding	Percent Occur- rence in Feeding Fish
Fish material:						
Salmon eggs	11	18.6	-	-	11	13.4
Unidentified fish remains	2	3.4	-	-	2	2.4
Crustacea:						
Isopods	-	-	1	4.3	1	1.2
Miscellaneous:						
Fresh water clams	-	-	2	8.7	2	2.4
Gastropods	38	64.4	16	70.0	54	65.9
Insects	13	22.0	3	13.0	16	19.5
Rocks & wood	1	1.7	8	34.8	9	11.0
Unidentified material	1	1.7	1	4.3	2	2.4
Number empty	117		242		359	
Number feeding	59		23		82	
Total examined	176		265		441	

Table 7. The number and percent of Dolly Varden stomachs containing food by life history period.

Life History Period	Number Examined	Number Empty	Number Feeding	Percent Feeding
Outmigration Eva weir	1,372	1,087	285	20.8
Salt water period	145	43	102	70.3
Immigration Saook weir	388	125	263	67.8
Immigration Eva weir	1,542	1,193	349	22.6
Eva Lake summer Residence	176	117	59	33.5
Eva Lake winter Residence	265	242	23	8.7
Total	3,888	2,807	1,081	27.8

Rate of Digestion

Eighteen Dolly Varden returning from the sea were captured at the Eva Creek weir and starved for 48 hours. They ranged in fork length from 216 to 280 mm with a mean of 247 mm. The weight ranged from 0.21 to 0.47 pounds with a mean of 0.33 pounds. Each Dolly Varden was force fed two freshly killed sockeye salmon fry of equal size (43 mm). At specific intervals of time, two Dolly Varden were sacrificed and the state of decomposition of the sockeye salmon fry was noted (Table 8). The water temperature remained a constant 56°F.

Digestion did not begin until four hours after feeding. The fry were identifiable to species up to 6 hours after feeding and to family up to 12 hours. At 16 hours after feeding the fry were classified as unidentifiable fish remains and by 24 hours most digestion had been completed.

Predation of Salmon Young

From a cursory examination of the literature one might conclude that many studies have been conducted on the Dolly Varden from the predation aspect. However, careful analysis of these references has revealed the opposite to be true. Only six references presented data sufficient enough to validate their conclusions. These six studies and a summary of their findings are presented in Table 9.

Only a single reference of the six considered the Dolly Varden to be a serious predator on salmon young (Ricker, 1941). In Ricker's study at Cultus Lake, British Columbia the cutthroat trout, coho salmon, squawfish, and prickly sculpins were also considered to be important predators on sockeye salmon young. Ricker considered the cutthroat trout as one of the most important, and at the time probably the most important predator in the lake. Although Ricker's findings do not eliminate the Dolly Varden as a predator, they do indicate that most all of the other fish capable of being predators in the lake were also predacious. Also the results showed that the Dolly Varden could not be singled out as the chief predator of salmon young.

Pritchard's (1936) work at McClinton Creek, British Columbia indicated that a high percent of Dolly Varden (97.1 percent) fed on salmon young. These figures can be misleading if it is not understood that the salmon young were concentrated in a small area by a fine wire screen constructed across the entire width of the stream. This screen served to guide the salmon young into a large rectangular pen. Thus, when the runs were at their height, there was a concentration of fry along the screens and in the pen. According to Pritchard: "there is little doubt but that, during this temporary crowding, the small fish more easily fall prey to their predators." Pritchard concluded "that from the point of view of absolute damage, the order, from greatest to least, is probably: coho salmon, cutthroat trout, Dolly Varden char, and cottid."

Roos (1959) examined the stomach contents of 5,050 Dolly Varden from the Chignik Lake system, Alaska. Of the 5,050 stomachs examined, 214 were feeding on salmon young. Roos states: "It is concluded from the evidence obtained that they are not serious predators upon the young salmon in the Chignik system."

Table 8. Rate of digestion in the Dolly Varden and observed condition of food at the indicated times after feeding.

Time in hours	Observed condition of sockeye salmon fry
2	Little or no digestion has taken place. Parr marks easily recognizable. Fry are identifiable to species.
4	Digestion beginning on the posterior part of the stomach. The head of the fry are now partly digested. Skin and scales mostly intact, parr marks still visible. Fry are identifiable to species.
6	Some skin and scales have been digested. One fry head completely digested, other still intact. Parr marks still visible. Fry are identifiable to species.
8	Skin and scales mostly digested on two fry. Parr marks still visible on other two fry. Heads mostly digested. Fry are identifiable to genera.
10	Skin and scales mostly or partly digested on all fry. Parr marks no longer visible. Flesh is soft and there is present a fair amount of jelly-like flesh. Fry are identifiable to family.
12	Skin and scales completely gone. Flesh is soft. Fry identifiable to family.
16	Flesh mostly digested. Bone structure still present. Identified as fish remains.
20	A small amount of bone structure present. Flesh almost completely digested. Identifiable as fish remains.
24	In one fish the fry were completely digested with only a small amount of jelly-like substance remaining. The other fish contained only a few bones.

Table 9. Previous investigations centered around the Dolly Varden as a predator on salmon young.

Investigator	Sampling Period	Number Sampled	Number Feeding	Number Feeding on Salmon	Percent Frequency of Feeding on Salmon Young	Did the Author Consider the Dolly Varden a Serious Predator
DeLacy, 1941	April-September	3,371	1,570	21	1.3	No
Lagler & Wright, 1962	June-August	183	143	4	2.8	Undecided
Pritchard, 1936	February-June	76	70	68	97.1	Undecided
Ricker, 1941	All Year	301	182	122	67.0	Yes
Roos, 1959	May-August	5,050	2,383	214	9.0	No
Savvaitova & Reshetnikov, 1961	June-September	529	438	1	0.2	No

In a later publication by Roos (1960) concerning the predation of young coho salmon on sockeye salmon fry at Chignik, he found that 30 percent of the cohos fed on sockeye salmon fry. Roos stated; "This incidence is seven times the number of juvenile sockeye salmon found in Dolly Varden stomachs."

At Karluk Lake, Alaska, DeLacy (1941) found that of 3,371 Dolly Varden examined, 21 contained salmon young. In a later publication DeLacy and Morton (1943) state: "that as judged by studies made at Karluk, the seriousness of the Dolly Varden as a salmon predator has often been overstated."

In the studies conducted by Savvaitova and Reshetnikov (1961) out of 529 Dolly Varden stomachs examined, one contained salmon young. They concluded: "In the regions examined, the char consume smelt and sticklebacks, which are food competitors of the young sockeye, and thus are more beneficial than harmful."

Lagler and Wright examined the stomach contents of 183 Dolly Varden captured in an estuary at Little Port Walter, Alaska. They found salmon remains in four (2.8 percent) of the feeding char.

Of the 3,888 Dolly Varden stomachs examined from the Eva and Saook stream systems, 25 (2.3 percent) of the 1,081 feeding char contained salmon young. The greatest amount of predation occurred in salt water where 22 (21.6 percent) of the feeding char contained salmon young.

Samples of cutthroat trout collected along with the Dolly Varden indicate that this species feeds more heavily on salmon young than do the Dolly Varden (Armstrong, 1963). In Eva Lake no Dolly Varden were found feeding on salmon young whereas 50 percent of the cutthroat trout stomachs examined contained young salmon.

To properly assess the food and feeding habits of Dolly Varden, all areas of habitation throughout all months of the year for each system should be thoroughly investigated. Also, these studies should be conducted over several years. Until such studies are formulated, only speculation on the degree of Dolly Varden predation of salmon will exist.

The evidence collected to date indicates that at certain times of the year and under certain conditions Dolly Varden will feed on salmon young. However, in most cases the amount of damage appears to be slight. In all the studies conducted, the Dolly Varden was either regarded as not a serious predator or not the most harmful predator. Until further evidence is collected the Dolly Varden should not be considered a serious threat as a predator of salmon young.

Predation on Salmon Eggs

The fact that Dolly Varden feed on salmon eggs is fairly well documented in our study and others (DeLacy, 1941; Roos, 1959; Savvaitova, 1960, and Savvaitova and Reshetnikov, 1961). To properly evaluate the amount of damage done by Dolly Varden feeding on salmon eggs, three fundamental questions should be answered; (1) Were the eggs taken directly out of the redds? (2) Were they drifting eggs washed out of the redds or dug up by other spawning salmon? (3) Would these drifting eggs normally survive if left unmolested?

Savvaitova (1960) states: "Our observations and the findings of I.I. Kuznetsov and A.Ya. Tarenetz suggest that char usually feed on dead eggs washed out of the redds by the current at the time of spawning, or by the digging up of the gravel by other salmon. V. Ya. Levanidov states: "that in chum salmon spawning, the number of eggs not deposited in the redds amounts to 25% even in places where the current is rather slow, while where the current is faster it amounts to 40-50%. The eggs washed out of the redds die and the chances of their safe development, if they were not taken by *S. malma*, are insignificant. Thus, in consuming the eggs and alevins washed out of the redds the char are not predators but rather "scavengers", destroying that which must die anyway."

McNeil (1962) after reviewing several articles dealing with the loss of trout and char eggs directly from the redds by predation stated: "There is no conclusive evidence that predators consume significant numbers of eggs from redds during spawning." It is unlikely that salmon eggs dislodged from their redds would have survived if they had not been eaten by the Dolly Varden.

General observations made on feeding Dolly Varden in Eva Creek suggest that the results closely parallel the study conducted by Savvaitova. Small groups (6-15) of Dolly Varden were repeatedly observed in close proximity to spawning pairs of pink and chum salmon near the weir. Dolly Varden were not observed entering the nest during the actual spawning act. However, whenever a female salmon would exhibit her normal digging action the char would immediately congregate around her. It is possible that these char were feeding on the eggs dislodged from a previous redd by the salmon's digging actions. Also, many of the char's stomachs contained salmon eggs in an advanced state of development which would indicate that they had been dislodged from a previous redd.

Until such observations are more thoroughly documented, no attempt should be made to draw definite conclusions on the effect of Dolly Varden feeding on salmon eggs. However, the evidence does indicate that little feeding, if any, is being done by Dolly Varden on viable eggs which would have otherwise survived.

SUMMARY

- 1) Stomach contents of 3,888 Dolly Varden were examined from fish captured during their outmigration at Eva Creek, in salt water, inmigrations at Eva and Saook Creeks and in Eva Lake during the summer and winter months.
- 2) The food of Dolly Varden during their outmigration period consisted of mostly insects which were found in 76.1 percent of the stomachs with food. Gastropods were second in abundance, occurring in 13.7 percent of the feeding char. Other food material included fish remains, salmon young, Dolly Varden young, salmon scales, and cottid eggs. The relative amount of feeding on certain food items during 1962, 1963, and 1964 remained about the same.
- 3) In salt water the principal food of the Dolly Varden by volume were salmon young (28.1 percent), capelin (21.7 percent), Pacific herring (17.1 percent), and mysids (9.0 percent). The principal foods by frequency of occurrence

were salmon young (21.6 percent), mysids (17.6 percent), amphipods (12.7 percent), and capelin (9.8 percent).

- 4) During the immigration at Saook Creek the Dolly Varden fed mostly on salmon eggs which occurred in 61.1 percent of the feeding char. Insects were second in abundance, occurring in 38.4 percent of the feeding char.
- 5) During the immigration at Eva Creek the Dolly Varden also fed primarily on salmon eggs which were found in 61.3 percent of the stomachs with food. Insects were second in abundance occurring in 16.6 percent of the feeding char.
- 6) During the summer months in Eva Lake the principal food items of Dolly Varden were gastropods, which were found in 64.4 percent of the stomachs containing food. Insects occurred in 22.0 percent, salmon eggs in 18.6 percent, and fish remains in 3.4 percent of the feeding Dolly Varden.
- 7) The Dolly Varden captured during the winter months in Eva Lake fed primarily on gastropods (70.0 percent), insects (13.0 percent), freshwater clams (8.7 percent), and isopods (4.3 percent).
- 8) The greatest amount of feeding occurred while the char were in salt water and the least amount of feeding was found to occur during the winter months in Eva Lake.
- 9) The digestive rate of Dolly Varden was studied by force feeding two sock-eye salmon fry to each of 18 char. The fry were identifiable as salmon up to 12 hours after feeding and as fish remains at 16 hours after feeding. By 24 hours most digestion had been completed.
- 10) The Dolly Varden as a predator of salmon young and eggs is discussed. It was concluded that until further evidence is collected the Dolly Varden should not be considered a serious threat as a predator on salmon young or on viable eggs which would have otherwise survived.

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